U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: STRUCTURAL SUBSTANTIATION OF SECONDARY STRUCTURES | **Date:** 9/5/85 | **Initiated by:** ACE-100 | **AC No:** 23-3 | **Change:**

1. PURPOSE. This advisory circular provides information and guidance concerning acceptable means, but not the only means, of demonstrating compliance with the requirements of Part 23 of the Federal Aviation Regulations (FAR) applicable to the structural substantiation of secondary structures such as fairings, cowlings, antennae, etc. This material is neither mandatory nor regulatory in nature and does not constitute a regulation.

2. RELATED FAR SECTION. Sections 23.251, 23.301, 23.303, 23.305, and 23.307.

3. DEFINITION. Secondary structures are those which are not primary load carrying members, and their failure would not reduce the structural integrity of the airframe or prevent the airplane from continuing safe flight and landing.

4. DISCUSSION.

a. In the past, there have been instances where flight tests to dive speed have been accepted as the only means of structurally substantiating secondary structures such as those mentioned above. Such an approval does not satisfy the requirement that the structure must support ultimate load. In other instances, flight testing to dive speed has not been accepted as the sole means of substantiation and applicants have presented additional data to show compliance with the requirements. Certain modifications or alterations involving secondary structures where the external contour did not change from the original type design (e.g., windshields, windows, radomes, etc.) have been approved by structural substantiation alone without a test to dive speed.

b. Normally, when flight testing to dive speed, intentional maneuvering is prudently limited, and such a test subjects the airplane structure to a low or moderate load factor, usually near one g, at limit dynamic pressure. This test will only verify that the structures in question will support limit load if the structure is one that does not experience loads which vary significantly with angle of attack or yaw (e.g., a tailcone with round or elliptical cross-section producing essentially a pure drag force). Therefore, in addition, further substantiation is necessary to show that such secondary structures will support ultimate loads.

c. In the case of secondary structures that experience forces which vary with angle of attack or yaw, it should be shown that critical limit load can be supported without detrimental permanent deformation and ultimate load can be supported without failure. This can often be accomplished by a simple conservative analysis.

d. Flight test to dive speed without further substantiation may be adequate for certain small parts which would not cause a hazard to the airplane or its occupants, or to persons on the ground, if they become detached in flight.

5. ACCEPTABLE MEANS OF COMPLIANCE. Compliance with the above-related regulations, with respect to structural substantiation of secondary structures, may be accomplished as follows:

a. Structural analysis or static test, or a combination, may be used as the sole means of showing compliance with both limit and ultimate load conditions covering the critical points on the limit flight envelope, provided that the basic loads have been obtained by flight test, wind tunnel test, or flight or wind tunnel test data derived from similar designs; or by an acceptable conservative analysis. The methods of achieving the above may involve a certain amount of engineering judgment. Some pertinent considerations are as follows:

(1) When basic loads are determined from wind tunnel test, it may be necessary to apply a conservative factor to ensure confidence in the full-scale loads. The need for such a factor will depend on considerations such as the test Reynolds number, flow similarity between the model and full-scale airplane, whether load data are measured directly on the affected structure or on adjacent structure, etc.

(2) Flight test data may be taken at one-g conditions covering the angle of attack range corresponding to the critical points on the limit flight envelope, with the data being corrected to the conditions (i.e., dynamic and static pressure) at those points. An alternative method, which would be more appropriate when compressibility effects are significant, is as follows: Measure loads in one-g straight flight and in steady turning flight at the same airspeed, at several higher load factors as permitted by the design flight envelope. Extrapolate the test data to determine the loads at limit load conditions. The test airspeed and altitude would be selected to obtain the desired Mach number. Another method would be to perform "roller coaster" maneuvers (pushovers and pull-ups) to produce load factors above and below one g. Use of this method depends on the method of measurement of loads and flight conditions being accurate in transient flight.

(3) For certain items (e.g., engine cowlings), it may be necessary to take the internal static pressure into account when it is expected that this pressure will be different from free stream static pressure, so as to cause a significant increase in the air load on the secondary structure.

b. Certain fairings which may experience an aerodynamic force which does not vary significantly with angle of attack or yaw (i.e., essentially a drag force) may be substantiated to limit load by flight test to dive speed (V_D), or by a conservative analysis, and substantiated to ultimate load by a conservative analysis.

c. At the discretion of the cognizant FAA Aircraft Certification Office, flight test to dive speed without further structural substantiation may be adequate for certain parts (small fairings, small access covers, etc.) which will obviously not constitute a hazard to the airplane or its occupants if they become detached in flight and are sufficiently small or light enough to be unlikely to cause a hazard to persons on the ground. Particular attention should be given to assessing the hazards associated with an aft engine or propeller installation; for example, a small part becoming detached may damage a pusher propeller or be ingested into an aft-located engine inlet.

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